Remarks

Further and favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

On page 2, lines 16 to 25 of the specification, there is a description that:

> "a sufficient amount of α to γ transformation is ensured by performing normalizing heat treatment which involves heating to a temperature of not less than the Ac_3 transformation point and holding at this temperature, thereby causing austenitizing to occur by phase transformation from α-phase to γ-phase, and after that, slow cooling is performed at a sufficiently low rate, i.e., at a rate of not more than the ferrite forming critical rate so that a ferrite structure can be obtained by phase transformation from γ-phase to α-phase". (Emphasis added)

Namely, a purpose of the heat treatment in the first step involving "heating to a temperature of not less than Ac_3 transformation point and holding at this temperature" is to ensure a sufficient amount of α to γ transformation and cause austenitization to occur. A purpose of the "slow cooling" in the second step is to obtain a ferrite structure by phase transformation from γ-phase to α-phase. It is therefore apparent that the heat treatment of the first step does not include a "cooling step".

The term "normalizing" technically means "to heat a ferrous alloy to some temperature above the transformation range, followed by air cooling" [see McGraw-Hill Dictionary of Scientific and Technical Terms: Second Edition, p.1099 (1978), a copy of which is attached hereto]. Therefore, the expression "normalizing heat treatment" on page 2, lines 17 to 18 of the specification is erroneously used, and it should be correctly described by merely "heat treatment" or by "austenitization heat treatment".

The erroneous expressions in the specification at page 2, lines 17 and 20; page 3, lines 6 and 11; page 15, line 2; and page 19, line 10 from the bottom have been corrected in accordance with the foregoing comments.

Claim 1 has been amended to incorporate the same subject matter concerning the excess oxygen content in the steel that is set forth in the last seven lines of claim 2.

The patentability of the presently claimed invention over the disclosure of the reference relied upon by the Examiner in rejecting the claims will be apparent upon consideration of the following remarks.

Thus, the rejection of claims 1 and 2 under 35 U.S.C. §103(a) as being unpatentable over Lambard et al. is respectfully traversed.

Feature of the present invention:

It is known that in order to improve the strength of an oxide dispersion strengthened ferritic steel (hereinafter referred to as "ODS ferritic steel"), it is effective to finely disperse the oxide particles by adding Ti to the steel [see page 2, lines 7 to 10 of the specification.] In addition, for improving the high-temperature creep strength of ODS ferritic steel, it is effective to form coarse grains in order to suppress grain-boundary slidings [page 2, lines 11 to 14 of the specification].

As a method of obtaining such a coarse grain structure, the specification cites Japanese Patent Laid-Open No. 11-343526/1999 [see page 2, the last line of the specification], which corresponds to the Lambard et al. reference (U. S. Patent No. 6,485,584) cited by the Examiner in the Official Action.

In Lambard et al., there is proposed a heat treatment wherein a sufficient amount of α to γ transformation is ensured by performing austenitization heat treatment which involves heating to a temperature of not less than the Ac_3 transformation point and holding at this temperature, thereby causing austenitization to occur by phase transformation from α-phase to γ-phase, and after that, slow cooling is performed at a sufficiently low rate, i.e., at a rate of not more than the ferrite-forming critical cooling rate so that an ODS ferritic structure can be obtained by phase transformation from γ-phase to α-phase.

However, in the case where Ti is added to an ODS ferritic steel, there occurs a problem that Ti combines with C in the matrix to form a carbide, with the result that the C concentration in the matrix decreases and hence it is impossible to ensure a sufficient amount of α to γ transformation during austenitization heat treatment. When untransformed α-phase is retained (microstructure has a dual phase), a coarse grain structure cannot be formed by slow cooling. Formation of a single phase of γ-phase is important and essential for obtaining a coarse grain structure [see page 3, lines 1 to 26 of the specification].

In Lambard et al., Ti is recited in claim 6 as one of the elements constituting ODS ferritic steel. However, the ODS ferritic steel "EM10 + Y_2O_3 ODS" actually produced in Examples 2 and 3 of Lambard et al. contains no Ti as shown in Table 1 of Lambard et al.

Therefore, Lambard et al. do not recognize the problem that when Ti is added, the coarse grain structure cannot be formed even by conducting the heat treatment (austenitization heat treatment + slow cooling heat treatment).

An object of the present invention is to provide a method of manufacturing an ODS ferritic steel having a coarse grain structure effective in improving high-temperature creep strength in which sufficient α to γ transformation during the austenitization heat treatment is ensured even when a Ti component is contained in the steel [see page 4, lines 2 to 9 of the specification].

In the present invention as claimed in amended claim 1, a TiO_2 powder is used as an element powder of a Ti component to be mixed at the mechanical alloying treatment, so that an excess oxygen content in the steel satisfies a predetermined conditional expression of grain coarsening.

In the present invention as claimed in claim 2, a Fe_2O_3 powder is additionally added as a raw material powder to be mixed at the mechanical alloying treatment, so that an excess oxygen content in the steel satisfies a predetermined conditional expression of grain coarsening.

The differences between the present invention and Lambard et al. are further explained below from viewpoints of chemical composition and process of manufacturing.

<u>Chemical composition: (see attached Table A)</u>

Table A indicated hereinbelow shows chemical compositions of sample materials of the present invention (T3 [manufactured by the process of claim 2], T7 [manufactured by the process of claim 1]) and sample material of ODS ferritic steel in Examples 2 and 3 of Lambard et al. (EM10 + Y_2O_3 ODS). The sample material T14 of the present invention is a comparative example in which Ti powder is added in place of TiO_2 powder.

As described hereinbefore, the fundamental difference resides in that a Ti component is contained in the ODS ferritic steel of the present invention and, in contrast, a Ti component is not contained in EM10 + Y_2O_3 ODS of Lambard et al.

Since Ti component is not contained in the ODS ferritic steel of Lambard et al., the conditional relationship between Ti, C and excess oxygen content (Ex.O) in the steel as proposed in the present invention cannot be obtained, and therefore, it is apparent that Lambard et al. does not recognize the effects of Ti and excess oxygen content in steel on formation of the coarse grain structure of the ODS ferritic steel. In other words, Lambard et al. do not teach or suggest the control of excess oxygen content within a predetermined range.

Accordingly, there are differences in chemical composition between the ODS ferritic steel of the present invention and that of Lambard et al.

Process of manufacturing and coarsening of grains: (see attached Table B)

In the process of manufacturing ODS ferritic steel of Lambard et al., the lower the rate of cooling in the thermal cycle (austenitization + slow cooling), the greater the increase in the grain size of the steel [col. 10, lines 64 to 65]. For example, in Table 3 of Example 2, there are shown grain size of 4.2 μm at cooling rate of 20 °C/h, and grain size of 8 μm at cooling rate of 6 °C/h.

Further, in the process of manufacturing ODS ferritic steel of Lambard et al., "at least one" thermal cycle is carried out. Table 4 of Example 3 shows that the maximum grain size achieved is 10 μm with at least four thermal cycles.

However, these Examples of Lambard et al. do not add a Ti component in the steel. When a Ti component is added in the ODS ferritic steel of Lambard et al., formation of coarse grains would not be expected even by carrying out the thermal cycle, as shown in the comparative example (T14) of the present application. Namely, in the case where Ti components are added in the process of manufacturing ODS ferritic steel of Lambard et al., the effective grain-coarsening effect is not always expected.

On the other hand, in the process of the present invention, even when a Ti component is added in the steel, the coarse grain structure can be surely formed by controlling excess oxygen content within a predetermined range and by carrying out a

single thermal cycle, i.e. heat treatment (austenitization heat treatment + slow cooling heat treatment). In addition, a grain size larger than that of Lambard et al. can be formed by using a rate of cooling faster than that of Lambard et al. (for example, grain size of about 15 μm at cooling rate of 37 °C/h) [see T3 and T7 in Table A].

Here, the single heat treatment in the process of the present invention is apparent from the expression "final heat treatment" in the claims. Namely, since the heat treatment involving austenitization heat treatment and slow cooling heat treatment is "finally" carried out, it means that such a heat treatment (austenitization heat treatment + slow cooling heat treatment) is carried out "once".

The control of excess oxygen content in the present invention is carried out to a very small level such as 0.01 to 0.1 wt %. In the general manufacturing process of ODS ferritic steel as used in the present invention, the content of contaminated excess oxygen fluctuates for every manufacturing batch, and therefore it is rather difficult to satisfy the limited range of excess oxygen content as defined in the claims. In order to severely and effectively control the small amount of excess oxygen content to the limited range, the inventors proposed the use of TiO_2 powder in place of element Ti powder (claim 1), and the additional use of Fe_2O_3 powder (claim 2), whereby a coarse grain structure effective in improving high-temperature creep strength can be formed even when a Ti component is added to the ODS ferritic steel.

In summary, Lambard et al. neither teach nor suggest that the excess oxygen content in steel has an important effect on formation of coarse grains when Ti component is added in steel, nor does the reference teach or suggest the use of TiO_2 powder or the additional use of Fe_2O_3 powder which enable control of excess oxygen content to a very small level to thereby limit the excess oxygen content within a predetermined range.

For these reasons, Applicants take the position that the presently claimed invention is patentable over the Lambard et al. reference.

Therefore, in view of the foregoing amendments and remarks, it is submitted that the ground of rejection set forth by the Examiner has been overcome, and that the application is in condition for allowance. Such allowance is solicited.

Respectfully submitted,

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Table A

	Sample material	Chemical composition (wt %)														
		C	Si	Mn	P	S	Ni	Cr	W	Mo	Ti	Y	O	N	Ar	Y_2O_3
Present invention	T3 (claim 2)	0.13	<0.005	<0.01	0.002	0.003	0.01	8.8	1.9	-	0.21	0.27	0.22	0.012	0.005	0.34
	T7 (claim 1)	0.14	<0.005	<0.01	0.003	0.003	0.01	8.5	1.9	-	0.14	0.27	0.29	0.014	0.006	0.34
	T14 (comp. ex.)	0.14	<0.005	<0.01	0.002	0.003	0.01	8.8	1.96	-	0.21	0.26	0.18	0.013	0.005	0.33
Lambard et al.	EM10+Y_2O_3 ODS	0.10	0.37	0.49	-	-	0.53	8.4	-	1.1	-	0.17	0.129	0.025	-	0.22

Table B

	Lambard et al.		Present invention	
Condition of heat treatment	[austenitization+slow cooling] once or more		[austenitization+slow cooling] once	
Sample material	EM10+Y_2O_3 ODS		T3, T7	T14
Chemical composition				
Addition of Ti	non-added		added	
Predetermined Ex.O range	-		satisfied	unsatisfied
Rate of cooling (°C/h)	20	6	37	37
Grain size (μm)	4.2	8	about 15 (*)	about <5 (*)

Note: The grain size marked with asterisk means average grain size measured from microphotgraphs of Figs. 1 and 2 of the present application.

McGraw-Hill DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS

Second Edition

it can be used for the determination of pressure standards; an instrument such as a large-bore mercury barometer is usually used.

normal benzine [MATER] A mixture of hydrocarbons; clear, colorless, water-insoluble liquid distilled from petroleum; boils at 65–95°C; density 0.695–0.705. Also known as benzoline.

normal bonded-phase chromatography [ANALY CHEM] A technique of bonded-phase chromatography in which the stationary phase is polar and the mobile phase is nonpolar.

normal chart [METEOROL] Any chart that shows the distribution of the official normal values of a meteorological element. Also known as normal map.

normal contour *See* accurate contour.

normal coordinates [MECH] A set of coordinates for a coupled system such that the equations of motion each involve only one of these coordinates.

normal curvature [MATH] The normal curvature at a point on a surface is the curvature of the normal section to the point.

normal curve *See* Gaussian curve.

normal cycle [GEOL] A cycle of erosion whereby a region is reduced to base level by running water, especially by the action of rivers. Also known as fluvial cycle of erosion.

normal density function [STAT] A normally distributed frequency distribution of a random variable x with mean e and variance σ is given by $(1/\sigma\sqrt{2\pi})\exp[-(x-e)^2/2\sigma^2]$.

normal derivative [MATH] The directional derivative of a function at a point on a given curve or surface in the direction of the normal to the curve or surface.

normal dip *See* regional dip.

normal direction flow [ADP] The direction from left to right or top to bottom in flow charting.

normal dispersion [OPTICS] Dispersion in which the refractive index decreases monotonically and continuously with increasing wavelength.

normal displacement *See* dip slip.

normal distribution [STAT] The most commonly occurring probability distributions have the form

$$(1/\sigma\sqrt{2\pi})\int_{-\infty}^{u}\exp(-u^2/2)du,\ u=(x-e)/\sigma$$

where e is the mean and σ is the variance. Also known as Gauss' error curve; Gaussian distribution.

normal divisor *See* normal subgroup.

normal effort [IND ENG] The effort expended by the average operator in performing manual work with average skill and application.

normal electrode [ELEC] Standard electrode used for measuring electrode potentials.

normal elemental time [IND ENG] The selected or average elemental time adjusted to obtain the elemental time used by an average qualified operator. Also known as base time; leveled elemental time.

normal erosion [GEOL] Erosion effected by prevailing agencies of the natural environment, including running water, rain, wind, waves, and organic weathering. Also known as geologic erosion.

normal family [MATH] A family of complex functions analytic in a common domain where every sequence of these functions has a subsequence converging uniformly on compact subsets of the domain to an analytic function on the domain or to $+\infty$.

normal fault [GEOL] A fault, usually of 45–90°, in which the hanging wall appears to have shifted downward in relation to the footwall. Also known as gravity fault; normal slip fault; slump fault.

normal fluid [CRYO] The component of liquid helium II, postulated in the two-fluid theory, that has viscosity and behaves like an ordinary fluid.

normal fold *See* symmetrical fold.

normal frequencies [MECH] The frequencies of the normal modes of vibration of a system.

normal function *See* normalized function.

normal horizontal separation *See* offset.

normal hydrostatic pressure [HYD] In porous strata or in a well, the pressure at a given point that is approximately equal to the weight of a column of water extending from the surface to that point.

normal impact [MECH] **1.** Impact on a plane perpendicular to the trajectory. **2.** Striking of a projectile against a surface that is perpendicular to the line of flight of the projectile.

normal impedance *See* free impedance.

normal-incidence pyrheliometer [ENG] An instrument that measures the energy in the solar beam; it usually measures the radiation that strikes a target at the end of a tube equipped with a shutter and baffles to collimate the beam.

normal incidence reflectivity [ELECTROMAG] The ratio of the energy of electromagnetic radiation reflected from the interface between two media to the energy of the incident radiation when the incident radiation travels in a direction perpendicular to the surface.

normal induction [ELECTROMAG] Limiting induction, either positive or negative, in a magnetic material that is under the influence of a magnetizing force which varies between two specific limits.

normality [CHEM] Measure of the number of gram-equivalent weights of a compound per liter of solution. Abbreviated N.

normalization [ADP] Breaking down of complex data structures into flat files.

normalize [ADP] **1.** To adjust the representation of a quantity so that this representation lies within a prescribed range. **2.** In particular, to adjust the exponent and mantissa of a floating point number so that the mantissa falls within a prescribed range. [MATH] To multiply a quantity by a suitable constant or scalar so that it then has norm one; that is, its norm is then equal to one. [MET] To heat a ferrous alloy to some temperature above the transformation range, followed by air cooling. [QUANT MECH] To multiply a wave function by a constant so that its norm is equal to unity. [STAT] To carry out a normal transformation on a variate.

normalized admittance [ELECTROMAG] The reciprocal of the normalized impedance.

normalized coupling coefficient [ELECTROMAG] Mutual inductance, expressed on a scale running from zero to one.

normalized current [ELECTROMAG] The current divided by the square root of the characteristic admittance of a waveguide or transmission line.

normalized function [MATH] A function with norm one; the norm is usually given by an integral $(\int|f|^p d\mu)^{1/p}$, $1\leq p<\infty$. Also known as normal function.

normalized impedance [ELECTROMAG] An impedance divided by the characteristic impedance of a transmission line or waveguide.

normalized Q [ELEC] The ratio of the reactive component of the impedance of a filter section to the resistive component.

normalized susceptance [ELECTROMAG] The susceptance of an element of a waveguide or transmission line divided by the characteristic admittance.

normalized voltage [ELECTROMAG] The voltage divided by the square root of the characteristic impedance of a waveguide or transmission line.

normally distributed observations [STAT] Any set of observations whose histogram looks like the normal curve.

normal magnetization curve [ELECTROMAG] Curve traced on a graph of magnetic induction versus magnetic field strength in an originally unmagnetized specimen, as the magnetic field strength is increased from zero. Also known as magnetization curve.

normal map *See* normal chart.

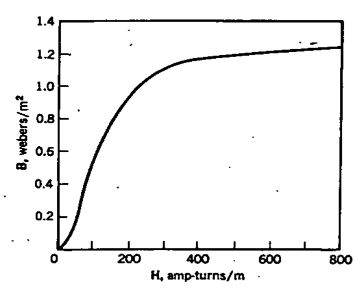
normal matrix [MATH] A matrix is normal if multiplying it on the right by its adjoint is the same as multiplying it on the left.

normal mode [ADP] Operation of a computer in which it executes its own instructions rather than those of a different computer.

normal-mode helix [ELECTROMAG] A type of helical antenna whose diameter and electrical length are considerably less than a wavelength, and which has a radiation pattern with greatest intensity normal to the helix axis.

normal mode of vibration [MECH] Vibration of a coupled system in which the value of one of the normal coordinates oscillates and the values of all the other coordinates remain stationary.

NORMAL MAGNETIZATION CURVE



Normal magnetization curve; the magnetic induction is the ordinate and the magnetic field strength is the abscissa.